

Hawaiian Aleyrodidae¹

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ABSTRACT

A key to the 18 species of Aleyrodidae known to occur in Hawaii is presented with accompanying photographs. Each species is listed under its currently accepted name followed by the author and reference in which it was first described, the date of establishment in Hawaii, worldwide distribution, natural enemies recorded in Hawaii, and a description.

The first record of whiteflies (Homoptera: Aleyrodidae) in Hawaii was in 1907 by Kotinsky. At that time there were 6 species found predominantly on the islands of Oahu and Hawaii. Today there are 18 species of whiteflies distributed throughout the islands (Table 1). Ten of these species were recorded in the state for the first time during the past 15 years.

The primary purposes of this paper are to provide a key to the known Hawaiian Aleyrodidae and their currently accepted names. The key is based on characteristics of the 4th nymphal instar, or "pupal" stage. It is not intended for use with earlier instars which do not have the same patterns of secretion as the 4th instar and therefore cannot be correctly identified using this key. Since many of the characteristics used in this key are based on secretions of the insect and not structural morphology, they will vary with the age and condition of the pupa. Therefore it is advisable to examine as many specimens as possible before making a determination. Photographic references are included to facilitate use of the key.

Specimens from the University of Hawaii, the Hawaii State Department of Agriculture, and the Bernice P. Bishop Museum collections, as well as specimens collected in the field by the authors were examined in constructing the key. The following species, which are included in the key, were not well represented in the collections: *Parabemisia myricae* (Kuwana 1927) and *Aleyrodes spiraeoides* (Quaintance 1900). Characteristics used in the key for these species are based on photographs and published descriptions.

Each species is listed under its currently accepted name followed by the author and reference in which it was first described, the first reference to the currently accepted name found in Hawaiian literature (predominantly the Proceedings of the Hawaiian Entomological Society), the date of establishment in Hawaii, worldwide distribution, natural enemies recorded in Hawaii and a description with accompanying photographs. Many of the descriptions included in the text are based on the original descriptions; exceptions have been indicated. A complete list of synonymy for each species can be found in Mound and Halsey (1978).

Photographs having a scale marker (in μm) on the lower border were taken with a scanning electron microscope (Cambridge Stereoscan 150) using specially prepared specimens. The remaining photographs were taken of freshly collected specimens using a 35 mm camera coupled to a dissecting microscope.

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TABLE 1. Distribution of Hawaiian Aleyrodidae species.

Species	Kauai	Oahu	Molokai	Lanai	Mauai	Hawaii
1. <i>Aleurocanthus spiniferus</i>	X	X	X	X	X	
2. <i>Aleurodicus dispersus</i>	X	X	X	X	X	X
3. <i>Aleurothrixus floccosus</i>	X	X	X	X	X	X
4. <i>Aleurotulus</i> sp.	X	X				X
5. <i>Aleyrodes shizuokensis</i>		X				
6. <i>Aleyrodes spiraeoides</i>					X	
7. <i>Bemisia giffardi</i>	X	X	X	X	X	
8. <i>Bemisia tabaci</i>		X				
9. <i>Crenidorsum</i> sp.		X				
10. <i>Dialeurodes citrifolii</i>	X	X	X	X	X	X
11. <i>Dialeurodes kirkaldyi</i>	X	X	X		X	X
12. <i>Odontaleyrodes rhododendri</i>		X			X	X
13. <i>Orchamoplatus mammaeferus</i>		X		X	X	X
14. <i>Parabemisia myricae</i>		X				X
15. <i>Paraleyrodes naranjiae</i>	X	X	X	X	X	X
16. <i>Paraleyrodes perseae</i>	X	X	X	X	X	X
17. <i>Singhius hibisci</i>		X	X		X	X
18. <i>Trialeurodes vaporariorum</i>	X	X	X	X	X	X

KEY TO THE SPECIES OF HAWAIIAN ALEYRODIDAE*

1. Pupal case yellow, tan/brown or obscured by secretions (Fig. 1F, 2E, 4F, 5H) 2
- Pupal case black (not to be confused with pupae having dark internal contents, especially parasitized pupae) 17
- 2(1). With white dorsal or marginal secretion and/or thin tail-like secretion projecting from caudal margin (Fig. 1F, 2E, 5H, 7B) 3
- Without white secretions 6
- 3(2). Dorsal surface covered with cotton-like secretions (Fig. 2E) ..
 *Aleurothrixus floccosus*
- Dorsal surface without cotton-like secretions (Fig. 1F, 5H, 7B) 4
- 4(3). With long thick white dorsal secretions (Fig. 1F) 5
- Without long thick white dorsal secretions (Fig. 5B, 5H) 8
- 5(4). Pupal case and adjacent leaf area usually covered by many broken fragments of white rods of variable length
 *Paraleyrodes naranjiae*
- Pupal case and adjacent leaf area not covered by fragments of white rods (Fig. 1F) *Aleurodicus dispersus*
- 6(2). Pupa surrounded by matrix of transparent secretions 7
- Pupa not surrounded by such matrix 9
- 7(6). Dorsum strongly convex, but little flattened at margin; submarginal area without spines *Aleyrodes spiraeoides*
- Dorsum slightly convex/submarginal area with series of rather long and slender spines *Parabemisia myricae*

*For Figures refer to pp. 117-124.

- 8(4). Pupa surrounded by matrix of transparent secretions, no long filamentous rods, dorsum usually bearing subtriangular patch of white powdery secretions, thin tail-like white secretion usually present; nymphal exuviae often remaining on dorsum (Fig. 5H, 6A) *Orchamoplatus mammaeferus*
 Pupa not surrounded by matrix of transparent secretions, with long rod-like secretions or wide ribbon-like marginal fringe, powdery secretions not as described (Fig. 5B, 7B) 15
- 9(6). Pupa broadly oval or subcircular (Fig. 3E, 4B, 8C) 10
 Pupa elongate, elliptical, usually on upper surface of leaf (Fig. 3B) *Bemisia giffardi*
- 10(9). With conspicuous tracheal folds (Fig. 4B, 4F) 11
 Without conspicuous tracheal folds (Fig. 6F, 8A, 8C) 12
- 11(10). Dark medial line from the thorax to the vasiform orifice present (Fig. 4F) *Dialeurodes kirkaldyi*
 Dark medial line absent (Fig. 4B) *Dialeurodes citrifolii*
- 12(10). On anthurium (Fig. 3C, 3F) *Crenidorsum* sp.
 On other hosts (Fig. 6F, 8A, 8C) 13
- 13(12). Yellow/green, caudal margin incised, long setae may be present on dorsum (Fig. 6H, 8B) 14
 Colorless; margin entire, separated from the rest of the case, forming a narrow border all around (not apparent in figures); no long setae on dorsum (Fig. 8C) *Aleyrodes shizuokensis*
- 14(13). 4 pairs of long setae on dorsum; semicircular chitinous indentation on margin roughly opposite the anterior spiracle (Fig. 6F, 6G) *Singhius hibisci*
 0-7 pairs of long setae on dorsum; no semicircular indentation on margin (Fig. 8A) *Bemisia tabaci*
- 15(8). Dorsum with rod-like secretions, marginal fringe narrow when present 16
 Dorsum without rod-like secretions, marginal fringe composed of long ribbon-like secretions (Fig. 5B)
 *Odontaleyrodes rhododendri*
- 16(15). Pupal case and adjacent leaf area covered by many fragments of white rods of variable length; pupa with white marginal fringe *Paraleyrodes perseae*
 Pupal case and adjacent leaf area not covered with fragments of white rods; marginal fringe colorless, opaque, not prominent *Trialeyrodes vaporariorum*
- 17(1). Eleven pairs of long spines and numerous short spines present on dorsum; pupa surrounded by distinct white marginal fringe *Aleurocanthus spiniferus*
 Spines on dorsum not as described; white secretions not distinctly marginal, often scattered over the leaf surface; on anthurium *Aleurotulus* sp.

Genus *Aleurocanthus* Quaintance and Baker

Aleurocanthus Quaintance and Baker 1914:102.

Aleurocanthus spiniferus (Quaintance 1903) (Fig. 1 A-E).

Aleurodes spinifera Quaintance 1903:63-64.

Aleurocanthus spiniferus (Quaintance), Mau 1976.

Found established in Hawaii in 1974.

Distribution: Japan, Kenya, Tanzania, Uganda, Mauritius, China, Hong Kong, India, Sri Lanka, Taiwan, Thailand, Vietnam, Marianas, Brunei, Malaysia, Philippines, Sumatra, Caroline Islands, U.S.A. (Hawaii).

Natural Enemies: Coleoptera: Coccinellidae

Serangium maculigerum Blackburn

Hymenoptera: Aphelinidae

Encarsia smithi (Silvestri)

Encarsia variegata Howard

Encarsia spp.

Egg: Exclusive of stalk, 0.2 mm by 0.1 mm; yellowish maturing to dark tan, curved and marked with minute polygonal areas. Stalk short, holding egg in upright position.

Pupa Case: Jet black, strongly convex, strong spines clearly evident. Dorsum without secretions, short white cottony fringe all around. Dorsum bears strong, heavy spines as follows: submarginal row of nine or ten on each side, projecting considerably above and beyond the case; subdorsal row of ten to twelve shorter spines on each side; nearer the medio-dorsal line, 4 pairs of spines on thorax and pair on abdominal segments 1, 2, 3, and 7. Vasiform orifice elevated on oblique, subconical protuberance. Opening subcordate and nearly filled by operculum, lingula obscure. Marginal rim composed of prominent, bluntly-rounded secretory tubes, incisions between them moderately deep and acute.

Adults: Radial sector of forewing with one flexure. Wings are charcoal gray with subcircular white spots. Head and thorax dark brown, abdomen orange.

Genus *Aleurodicus* Douglas

Aleurodicus Douglas in Morgan 1893:32.

Aleurodicus dispersus Russell 1965 (Fig. 1 F-H, Fig. 2 A-D).

Aleurodicus dispersus Russell 1965:49-52.

Aleurodicus dispersus Russell, Nakahara 1978.

Found established in Hawaii in 1978.

Distribution: Panama, Barbados, Dominica, Ecuador, Cuba, Costa Rica, Martinique, Peru, Canary Islands, Brazil, U.S.A. (Florida, Hawaii), Guam, American Samoa.

Natural Enemies: Coleoptera: Coccinellidae

Coelophora pupillata (Swartz)

Cryptolaemus montrouzieri Mulsant

Curinus coeruleus Mulsant

Delphastus pusillus (LeConte)

Nephaspis amnicola Wingo

Nephaspis bicolor Gordon

Olla abdominalis (Say)

Olla abdominalis var. *plagiata* (Casey)

Serangium maculigerum Blackburn

Diptera: Syrphidae

Allograpta obliqua (Say)

Hymenoptera: Aphelinidae

Encarsia sp. poss. *haitiensis* Dozier

Encarsia sp.

Neuroptera: Chrysopidae

Chrysopa comanche Banks

Neuroptera: Hemerobiidae

Symphorobius barberi Banks

Egg: Elliptical, about 1.85 mm by 0.90 mm; yellow/tan, surface smooth. Prostrate on leaf, distributed throughout leaf at right angles to leaf veins in association with irregularly spiraling deposits of white flocculence.

Pupal Case: Copious amounts of white secretion extending upward and outward from dorsum; some fluffy, some thick and in ribbons as long as, or longer than, width of body; white glass-like rod arising from each compound pore, 3–4 times longer than width of body; band of whitish translucent striated secretions present extending from ventral submargin to leaf. Case colorless or yellowish. Nearly oval, 1–1.25 mm by 0.75–0.90 mm. Segmentation distinct. Compound pores in 1 subdorsal pair on prothorax and on each abdominal segments 3–6. Two submarginal rows of pores all around. Eleven pairs of submarginal setae; 3 on cephalic segment, and 1 on each of pro- and mesothorax, on combined abdominal segments 1 and 2, and on each of abdominal segments 3–7. Vasiiform orifice subcordate, operculum transverse, subrectangular about $\frac{1}{2}$ as long as orifice, broadly rounded apically, bearing 2 pairs of setae.

Adults: Body whitish, eyes dark red-brown. Forewing white with pale dark spot extending from costal margin to angle formed by branching of R, and another dark spot distally in angle between R₁ and R₂.

Genus *Aleurothrixus* Quaintance and Baker

Aleurothrixus Quaintance and Baker 1914:103–104.

Aleurothrixus floccosus (Maskell 1985) (Fig. 2 E-H).

Aleurodes floccosa Maskell 1895:432–433.

Aleurothrixus floccosus (Maskell), Matayoshi and Yoshioka 1981.

Found established in Hawaii in 1981.

Distribution: Canary Islands, Madeira, Spain, Angola, Congo, Reunion Island, Mexico, Bahamas, Trinidad, Cuba, Jamaica, Haiti, Puerto Rico, Panama, Argentina, Brazil, Chile, Guyana, Paraguay, Surinam, U.S.A. (Hawaii, California, Florida, Texas).

Natural Enemies: Coleoptera: Coccinellidae

Coelophora pupillata (Swartz)

Delphastus pusillus (LeConte)

Nephaspis amnicola Wingo

Orcus chalybeus (Boisduval)

Serangium maculigerum Blackburn

Diptera: Syrphidae

Allograpta obliqua (Say)

Hymenoptera: Aphelinidae

Encarsia sp. poss. *haitiensis* Dozier

Cales noacki Howard

Eretmocerus n. sp.

Hymenoptera: Platygasteridae

Amitus spiniferus (Brethes)

Egg: Curved, about 0.18 mm by 0.09 mm. Surface smooth, pedicel short, holding egg in a prostrate position. Eggs arranged in circles and arcs on the surface.

Pupal Case: Suboval, about 0.90 mm by 0.55 mm. White to pale yellow maturing to brown. Distinct marginal rim all around, secretory tubes distinct, incisions acute and tubes rounded distally. Case usually covered by curling rods and cottony threads. Abdominal segmentation distinct, dorsum convex, bearing 6 long slender spines in pairs, 1 pair is on the 1st abdominal segment, another pair laterad of vasiform orifice and 3rd pair on caudal margin. Vasiform orifice small, subcordate, with 6-8 strong setae arising from caudal margin (often obscured by secretions); operculum nearly filling orifice, distal end with 2 faint notches, lingula not distinguishable.

Adults: Body about 0.80 mm long; yellow; wings powdery white without markings, radial sector with one flexure, very small (smallest found in Hawaii).

(Based on: Quaintance 1907 and Maskell 1895)

Genus *Aleurotulus* Quaintance and Baker

Aleurotulus Quaintance and Baker 1914:101-102.

Aleurotulus sp. Nakahara 1981.

Found established in Hawaii in 1978.

Distribution: Uncertain.

Natural Enemies: Unknown.

Genus *Aleyrodes* Latreille

Aleyrodes Latreille 1795:93.

Aleyrodes shizuokensis Kuwana 1911 (Fig. 8 C-F).

Aleyrodes shizuokensis Kuwana 1911:620-622.

Aleyrodes shizuokensis Kuwana, Zimmerman 1946.

Found established in Hawaii in 1925.

Distribution: U.S.A. (Hawaii), India, Japan, Taiwan.

Natural Enemies: Unknown.

Pupal Case: Subcircular, about 0.99 mm by 0.70 mm colorless, no lateral fringe or secreted covering of any kind. Abdominal segmentation distinct. Margin crenate, separated from the rest of case, forming narrow border all around. Vasiform orifice subcordate, caudal end pointed. Operculum less than ½ length of orifice and not filling orifice in width. Distal end free, truncate. Lingula well developed, nearly as long as the orifice, distal portion convex, spatulate, enlarged, portion projecting beyond operculum setose.

Adults: Body yellow, thoracic sutures dark. Eyes red. Forewing with 2 flexures in radial sector, an indistinct dusky spot near distal end. Antennae are 7 jointed, 3rd joint longer than rest of segments put together.

Aleyrodes spiraeoides (Quaintance 1900).

Aleyrodes spiraeoides Quaintance 1900:36-38.

Aleyrodes spiraeoides (Quaintance), Zimmerman 1946.

Found established in 1945.

Distribution: U.S.A. (California, Hawaii).

Natural Enemies: Unknown.

Pupal Case: Broadly elliptical, 1.15 mm by 0.83 mm. Bright yellow. Mature specimens appear reddish due to developing pupae within. Case convex, flattened slightly at margin. Margin crenulated. Small pairs of setae may occur on cephalic and caudal margins. Larger pair of setae found on dorsum just within caudal margin, caudad of vasiform orifice. Abdominal segmentation somewhat distinct. No dorsal secretions present but slanting rim found in older specimens. Vasiform orifice subcordate. Operculum less than $\frac{1}{2}$ length of orifice and not filling it in width. Distal end free, truncate. Lingula well developed, nearly as long as orifice. Distal end spatulate and minutely setose, bearing 2 small lobes, 2 long setae project caudad from ventral surface of distal end.

Adults: Body yellow, thorax marked with black. Eye red. Forewing with 2 flexures in radial sector, 2 indistinct dusky spots, a small patch at about middle of the wing and larger spot near distal end of main vein. Antennae are 7 segmented, the 3rd segment as long as segments 4, 5 and 6 together.

Genus *Bemisia* Quaintance and Baker

Bemisia Quaintance and Baker 1914:99-100.

Bemisia giffardi (Kotinsky 1907) (Fig. 3 A-B).

Aleyrodes giffardi Kotinsky 1907:94-95.

Date of establishment unknown, prior to 1907.

Distribution: Japan, India, Nepal, China, Taiwan, Thailand, Vietnam, Malaysia, Java, Sumatra, Australia, New Caledonia, U.S.A. (Hawaii).

Natural Enemies: Unknown.

Egg: Pyriform, 1.95 mm by 0.90 mm at widest point. Dark brown. Fastened to leaf on its point in erect position.

Pupal Case: Elongate, subelliptical, 1.2 mm by 0.6 mm, uniform pale green/yellow. Slightly convex, rectangular area present between longitudinal ridges located on each side about $\frac{1}{3}$ distance from medio-dorsal line to margin, segmentation distinct in this area. Four prominent spines arise on each longitudinal ridge; 1 at cephalic end, 2 on thorax and 1 on abdomen. Pair of spines also anterior to vasiform orifice and one prominent spine found on each side of caudal cleft. Margin crenate, thoracic tracheal pores prominent. Vasiform orifice elongate, triangular with rounded angles, inner lateral margin crenate, outwardly lined on each side by band of chitin which extends to caudal margin. Operculum very small, about 0.04 mm long, lunar in outline. Lingula elongate, $\frac{4}{5}$ length of orifice, with small knob at apex bearing 2 long spines.

Adults: Body dark yellow, eyes red-brown. Tip of rostrum black, reaching hind coxae. Forewing yellowish dusted with wax, hindwing membranous white.

Bemisia tabaci (Gennadius 1889) (Fig. 8 A-B).

Aleyrodes tabaci Gennadius 1889:1-3.

Bemisia tabaci (Gennadius).

Found established in Hawaii in 1983.

Distribution: England, Spain, Morocco, Libya, Greece, Egypt, Cyprus, Israel, Jordan, Saudi Arabia, Iraq, Iran, U.S.S.R., Japan, Gambia, Sierra Leone, Ivory Coast, Ghana, Nigeria, Central African Republic, Chad, Sudan, Ethiopia, Congo, Zaire, Uganda, Kenya, Somali Republic, Tanzania, Angola, Zimbabwe, Malawi, Mozambique, Madagascar, Mauritius, Pakistan, India, Sri Lanka, Thailand, China, Taiwan, Marianas Islands, Malaya, Sumatra, Philippines, Papua-NewGuinea, Caro-

line Islands, Australia, Fiji, Jamaica, Puerto Rico, Barbados, Argentina, Brazil, U.S.A. (California, Florida, Hawaii).

Natural Enemies: Hymenoptera: Aphelinidae

Encarsia transvena (Timberlake)

Egg: Subelliptical, truncate at basal end, about 1.10 mm by 0.52 mm. Pedicel short, holding egg in upright position. Yellow-green maturing to brown black. Scattered singly on lower leaf surface.

Pupal Case: Suboval, about 0.98 mm by 0.68 mm, widest at metathorax, narrower posteriorly, distinctly constricted at thoracic combs, slightly incised at caudal end. Yellow to yellow-green. Margin crenate, teeth minute, rounded, irregular in shape and size, short ridge of variable length arising from each marginal tooth. Transverse suture distinct, abdominal and thoracic segmentation evident. Vasiform orifice triangular, about 1.3 times as long as wide, lateral margins slightly concave. Operculum subrectangular, slightly shorter than $\frac{1}{2}$ of orifice. Lingula exposed, knobbed, knobbed portion a little longer than wide and distinctly tapering from near base, pointed apically. Operculum and lingula setose, latter armed with subapical pair of setae. Caudal furrow distinct. Considerable variation in number and arrangement of dorsal setae in individuals, especially in individuals collected from different host species. Some specimens with up to 8 pairs of well developed spines, while others with no dorsal spines. Pairs of abdominal, sub-dorsal and mid-dorsal tubercles usually present.

(Based on: Takahashi 1957 and Corbett 1926)

Genus *Crenidorsum* Russell

Crenidorsum Russell 1945:55-57.

Crenidorsum sp. (Fig. 3 C-F).

Crenidorsum Sp. Nakahara 1981.

Found established in Hawaii in 1978.

Distribution: Unknown.

Natural Enemies: Unknown.

Pupal Case: Suboval, posterior end narrower and less broadly curved than anterior end. About 0.91 mm by 0.75 mm. Colorless, opaque, no apparent secretions. marginal teeth twice as wide as long, ridges from margin ending in outer subdorsum. Well defined ridge extending from cephalothoracic suture to 5th abdominal segment. Segmentation distinct. Ten long setae distributed in pairs as follows: 1 submedial on pro-, meso-, and meta- thoracic segments each about 1.25 mm long, another on 8th abdominal segment cephalo-lateral from vasiform orifice and last on posterior end of caudal ridge. Latter two pairs each about 1.0 mm in length. Vasiform orifice nearly twice its length from caudal margin, suboval, 0.44-0.56 mm, inner edge of rim weakly defined around anterior end of orifice, very short lip between it and margin of orifice. Operculum weakly or not sculptured, slightly narrower than orifice, not quite filling it in length. Caudal furrow and ridges well defined, reaching well toward margin.

(Based on Russell 1945)

Genus *Dialeurodes* Cockerell

Aleyrodes (*Dialeurodes*) Cockerell 1902:283.

Dialeurodes Cockerell, (as a full genus) Quaintance and Baker 1914:97.

Dialeurodes citrifolii (Morgan 1893) (Fig. 3 G, H, Fig. 4 A-C).

Aleyrodes citrifolii Morgan 1893:70-74.

Dialeurodes citrifolii (Morgan), Chong 1967.

Found established in Hawaii in 1966.

Distribution: Japan, India, China, Vietnam, Mexico, Jamaica, Puerto Rico, Bermuda, Barbados, Trinidad, Venezuela, Brazil, U.S.A. (California, Florida, Texas, Mississippi, North Carolina, Louisiana, Hawaii).

Natural Enemies: Unknown.

Egg: Elliptical, elongate. White maturing to dark gray/black. Covered with reticulated waxy, hexagonal facet, mesh. Stalk short, holding the egg in upright position.

Pupal Case: Subcircular, 1.75 mm by 1.30 mm. Greenish yellow. Margin very minutely serrate. Dorsum closely set with irregular more or less circular markings. Abdominal segmentation distinct. Thoracic tracheal folds and pores distinct. Pores armed with distinct fimbriae. Vasiform orifice subcordate, inner caudal margin armed with distinct teeth. Operculum similar in shape nearly filling orifice. Minute seta situated on each side of orifice.

Adults: Body yellow, dusted with fine white powder. Eyes dark brown. Wings white and powdery with large dusky spot on distal extremity of forewing.

Dialeurodes kirkaldyi (Kotinsky 1907) (Fig. 4 D-H, Fig. 5 A).

Aleyrodes kirkaldyi Kotinsky 1907:95-96.

Dialeurodes kirkaldyi (Kotinsky) Swezey 1943.

Date of establishment: Unknown, prior to 1907.

Distribution: Japan, Azores, Lebanon, Syria, Egypt, Ghana, Ivory Coast, Pakistan, India, Sri Lanka, Burma, China, Marianas, Taiwan, Philippines, Malaysia, Australia, Cuba, Jamaica, Trinidad, Guyana, Caroline Islands, Society Islands, Tuamotu Islands, New Caledonia, U.S.A. (Florida, Hawaii).

Natural Enemies: Unknown.

Egg: Suboval, about 1.80 mm by 0.90 mm. Yellowish when oviposited maturing to dark brown. Surface smooth. Pedicel short holding egg in upright position.

Pupal Case: Subcircular, about 1.25 mm by 0.95 mm. Greenish yellow with median longitudinal brown marking. Abdominal segmentation distinct. Thoracic tracheal folds and pores distinct. Pores without distinct fimbriae but with distinct rim. Margin crenate, separated from rest of case forming narrow border all around. Vasiform orifice subcordate, cephalic margin straight. Inner caudal margin armed with distinct teeth. Operculum similar in shape nearly filling orifice. Minute seta situated on each side of orifice.

Adults: Body dark yellow, eyes dark brown. Wings yellowish white and powdery without markings.

Genus *Odontaleyrodes* Takahashi

Odontaleyrodes Takahashi 1954:49-50.

Odontaleyrodes rhododendri (Takahashi) 1935 (Fig. 5 B-C).

Pealius rhododendri Takahashi 1935:279-280.

Odontaleyrodes rhododendri (Takahashi) Beardsley, Matayoshi, Mau and Nakahara 1979.

Found established in Hawaii in 1976.

Distribution: Japan, Taiwan, U.S.A. (Florida, Hawaii).

Natural Enemies: Hymenoptera: Aphelinidae

Encarsia transvena (Timberlake)

Pupal Case: Subelliptical, about 0.80 mm by 0.51 mm, broadest at basal part of abdomen. Yellow-brown with long ribbon-like white fringe along whole margin. Abdominal and thoracic segmentation distinct. Dorsum lacking papillae, ridges and long setae, with some minute circular pores, some short linear markings running mesad from margin, and short seta laterad of each side of base of vasiform orifice. Margin distinctly crenate, teeth rather large, in 2 rows, short very fine setae arranged in row along whole margin. Vasiform orifice large, nearly as wide as long, truncate or slightly indented on hind margin. Operculum much wider than long, straight on hind margin, occupying less than $\frac{1}{2}$ the orifice. Lingula knobbed, extending beyond operculum, knobbed portion longer than wide with pair of long setae.

Genus *Orchamoplatus* Russell

Aleuoplatus (*Orchamus*) Quaintance and Baker 1917:400.

Orchamus Quaintance and Baker, as full genus, Dumbleton 1956:131–132.

[Homonym of *Orchamus* Stål 1876:30 (Orthoptera).]

Orchamoplatus Russell 1958:390–391. [Replacement name for *Orchamus* Quaintance and Baker.]

Orchamoplatus mammaeferus (Quaintance and Baker) 1917 (Fig. 5 D-H, Fig. 6 A-E).

Aleuoplatus (*Orchamus*) *mammaeferus* Quaintance and Baker 1917:400–401.

Orchamoplatus mammaeferus (Quaintance and Baker), Nakahara 1979.

Found established in Hawaii in 1976.

Distribution: Japan, Java, Malaysia, Singapore, Australia, New Zealand, Fiji, Samoa, Cook Islands, Tahiti, Marquesas Islands, U.S.A. (Hawaii).

Natural Enemies: Coleoptera: Coccinellidae

Delphastus pusillus (LeConte)

Nephaspis amnicola Wingo

Orcus chalybeus (Boisduval)

Serangium maculigerum Blackburn

Hymenoptera: Aphelinidae

Encarsia transvena (Timberlake)

Encarsia sp.

Eretomocerus n. sp.

Eggs: Curved, about 0.20 mm by 0.90 mm. White, maturing to dark brown. Pedicel short holding egg in prostrate position on leaf. Eggs laid in distinct circles and arcs, often traversing leaf vein, often more than 30 eggs in ring.

Pupal Case: Oval, constricted at thoracic tracheal folds, about 0.75 mm by 0.55 mm. Margin somewhat crenate, armed with very shallow rounded teeth. Abdominal segmentation demarked medianly, sometimes obscured by dorsal subtriangular patch of white powdery secretions. Row of prominent papillae all around just within margin. Pair of strong median spines immediately behind transverse suture. Pair of short spines at anterior lateral angle of vasiform orifice and another large pair submarginally on either side of caudal comb. Vasiform orifice broadly rounded, anterior margin straight, inner latero-caudal margins armed with series of distinct teeth. Operculum similar in shape, not quite filling orifice, caudal, free end, setose. Opaque white/yellow, thin coat of transparent secretions forming thick layer around margin, raising pupal case from leaf surface, white tail-like secretion projecting posteriorly from caudal margin.

Adults: Body yellow, eyes red/brown. Wings white and powdery without markings.

Genus *Parabemisia* Takahashi

Parabemisia Takahashi 1952:21-22.

Parabemisia myricae (Kuwana 1927).

Bemisia myricae Kuwana 1927:249-251.

Date of establishment: Unknown, early 1960s.

Distribution: Japan, Taiwan, Malaysia, U.S.A. (California, Hawaii).

Natural Enemies: Unknown.

Pupal Case: Oval, about 0.80 mm by 0.60 mm. Pale greenish yellow. Dorsum slightly convex, covered with thin layer of transparent secretions, fringe of transparent secretions extending from case margin all around. Margin distinctly and uniformly crenate. no demarcation between margin and dorsal disc. Submarginal area armed all around with series of long spines, about 32 in all. Pair of inconspicuous hairs present on both posterior lateral margin and cephalothorax. Two spur-like spines 1 on each side of vasiform orifice, and pair of fine spines above orifice. Vasiform orifice subtriangular, about $\frac{3}{4}$ as wide as long, cephalic and lateral margins forming nearly straight line; lateral margin with corrugations or folds, extending downward and inward at caudal end of orifice. Operculum subequal in shape less than $\frac{1}{2}$ length of orifice. Lingula about $\frac{5}{6}$ length of orifice, distal end enlarged and arrow-shaped, heavily setose, terminating in 2 straight spines.

Genus *Paraleyrodes* Quaintance

Paraleyrodes Quaintance 1909:169-170.

Paraleyrodes naranjæ Dozier 1927 (Fig. 7 E-H).

Paraleyrodes naranjæ Dozier 1927:853-855.

Paraleyrodes naranjæ Dozier, Higa and Nakahara 1979.

Found established in Hawaii in 1976.

Distribution: Puerto Rico, U.S.A. (Hawaii).

Natural Enemies: Coleoptera: Coccinellidae

Coelophora pupillata (Swartz)

Nephaspis amnicola Wingo

Hymenoptera: Aphelinidae

Encarsia variegata Howard

Egg: Suboval, 0.24 mm by 0.11 mm. Pedicel long, about 0.12 mm long, in the middle at 90° angle, holding egg in prostrate position. Pale yellow. Scattered over leaf surface, usually in association with prominent deposits of white flocculence.

Pupal Case: Scattered over leaf surface as small white rosettes that measure 1.50 mm long. Case fringed with very broad white filaments that curl downward, case being completely hidden by other very broad thick filaments that arise from dorsal pores and grow upward, curving slightly. Long rods produced by dorsal pores extend vertically from case, case and adjacent leaf area covered with many fragments of these rods in variable lengths. Exposed case whitish with yellow/green cast. Size about 0.85 mm by 0.50 mm. Suboval, widest cephalad. Thoracic segmentation apparent, abdominal segmentation distinct. Row of short marginal spines all around. Seven pairs of dorsal compound pores, situated as follows; pair on cephalic end and 6 pairs on abdominal segments, cephalic pair of these nearer median line. Vasiform orifice subcordate, operculum subrectangular, caudal end almost straight, $\frac{1}{2}$ length and $\frac{4}{5}$ the width of orifice. Lingula large, longer than orifice, spatulate distally, setose, bearing 2 pairs of large setae.

Adults: Body uniform pale yellow, claspers of male reddish in fresh specimens. Eyes dark red brown. Antennae 4 segmented. Forewing with dusky markings distally medially and proximally, remainder of wing white and powdery. Adults often found in "nests" of white flocculent material.

Paraleyrodes perseae (Quaintance 1900).

Aleurodes perseae Quaintance 1900:32-33.

Paraleyrodes perseae (Quaintance), Beardsley 1970.

Found established in Hawaii in 1969.

Distribution: Mexico, Cuba, U.S.A. (Florida, Hawaii).

Natural Enemies: Hymenoptera: Aphelinidae

Encarsia variegata Howard

Egg: Elliptical, about 0.24 mm by 0.12 mm. Pedicel long about 0.15 mm long with obtuse bend in middle, holding egg in prostrate position on leaf. Eggs scattered singly about leaf, usually in association with prominent deposits of white flocculence.

Pupal Case: Suboval, about 0.86 mm by 0.53 mm. Yellow brown. Marginal fringe of more or less curled, short, white ribbons all around. Long white rods produced by dorsal compound pores protrude from case, case and adjacent leaf area covered with fragments of these rods of varying length. Seven pairs of dorsal compound pores distributed as follows: pair on cephalic end and 6 pairs on abdominal segments, cephalic 2 pairs of these smaller and near median line. Abdominal segmentation distinct, thoracic segmentation apparent. Submarginal row of setae all around. Vaisform orifice subcordate. Operculum subrectangular, considerably wider than long, caudal margin almost straight. Lingula large, longer than orifice, distal end spatulate and bearing 2 pairs of setae.

Adults: Body buff, marked with white. Forewings predominantly dusky with white areas distally, medially, and proximally. Copious amount of flocculent white wax secreted, becoming scattered over leaf surface. Adults often found resting in small depressions of wax covering.

Genus *Singhius* Takahashi

Dialeurodes (*Singhius*) Takahashi 1932:14.

Singhius hibisci (Kotinsky 1907) (Fig. 6 F-H).

Aleyrodes hibisci Kotinsky 1907:96-97.

Date of establishment: Unknown, prior to 1907.

Distribution: India, Thailand, Cambodia, Malaysia, Taiwan, New Caledonia, U.S.A. (Hawaii).

Natural Enemies: Hymenoptera: Aphelinidae

Eretmocerus corni Haldeman

Egg: Suboval, truncate basally, about 0.26 mm by 0.08 mm. Greenish yellow, scattered singly over leaf surface. Held in erect position by pedicel which is about 0.08 mm.

Pupal Case: Oval, about 0.81 mm by 0.72 mm, uniform lemon yellow; no fringe or covering of secretions. Margin crenate, caudal end incised. Four setae on each side of medio-dorsal line; 1 at suture between abdomen and thorax; 1 just anterior of vasiform orifice and 1 just anterior of caudal margin. Semicircular, chitinous indentation on margin roughly opposite anterior spiracle. Vasiform orifice rectangular, wider than long; operculum similar in outline, 4/5 length. Lingula trilobed, extending beyond orifice.

Adults: Abdomen lemon yellow, thorax and head sometimes pale orange, eyes dark red brown within frame of yellow facets. Wings white and powdery.

Genus *Trialeurodes* Cockerell

Aleyrodes (*Trialeurodes*) Cockerell 1902:283.

Trialeurodes Cockerell, Quaintance and Baker 1915:xi.

Trialeurodes vaporariorum (Westwood 1856) (Fig. 7 A-D).

Aleyrodes vaporariorum Westwood 1856:852.

Aleyrodes sonchi Kotinsky 1907.

Date of establishment: Unknown, prior to 1907.

Distribution: England, Scotland, Denmark, France, Germany, Italy, Norway, Spain, Switzerland, Sweden, Austria, Belgium, Czechoslovakia, Hungary, Poland, Rumania, Yugoslavia, U.S.S.R., Iran, Canary Islands, Madeira, Morocco, Central African Republic, Ethiopia, Kenya, Zimbabwe, South Africa, Sri Lanka, India, Malaysia, new Guinea, Australia, New Zealand, Bermuda, Canada, Puerto Rico, Barbados, Mexico, Guatemala, Honduras, El Salvador, Colombia, Argentina, Brazil, Chile, Ecuador, Guyana, Peru, U.S.A. (including Alaska and Hawaii).

Natural Enemies: Coleoptera: Coccinellidae

Dephastus pusillus (LeConte)

Hymenoptera: Aphelinidae

Aleurodiphilus pergandiellus (Howard)

Encarsia formosa Gahan

Encarsia transvena (Timberlake)

Eretmocerus sp.

Eggs: Subelliptical, truncate at basal end, about 1.20 mm by 0.65 mm. Pedicel short, about 0.15 mm long, often inserted entirely into leaf, holds egg in upright position. Whitish green maturing to black. Surface irregularly punctate. Distributed in evenly spaced circles and arcs, may be distributed irregularly if leaf surface pubescent.

Pupal Case: Suboval, about 1.85 mm by 1.20 mm. Opaque greenish. Surrounded by regularly spaced fringe of glassy rods arising from submarginal pores. Margin somewhat crenate. Pupa slightly elevated above leaf surface, dorsum flat. Abdominal segmentation distinct. Numerous long glassy rods projecting vertically from case as follows: 3 submarginal rods and 2 midway between margin and median on each side of thorax; on abdomen, 4 submarginal rods and 2 midway between margin and median on segments 3 and 4. Vasiform orifice subcordate, inner latero-caudal margins armed with series of teeth. Operculum subovate $\frac{2}{3}$ length of orifice. Lingula about $\frac{3}{4}$ length of orifice, distal end with 5 lobes, 2 small lateral pairs and 1 broad median lobe. Setose, 2 large setae projecting posteriorly.

Adults: Body light yellow, eyes dark red, wings white and powdery.

(Based on Kotinsky 1907.)

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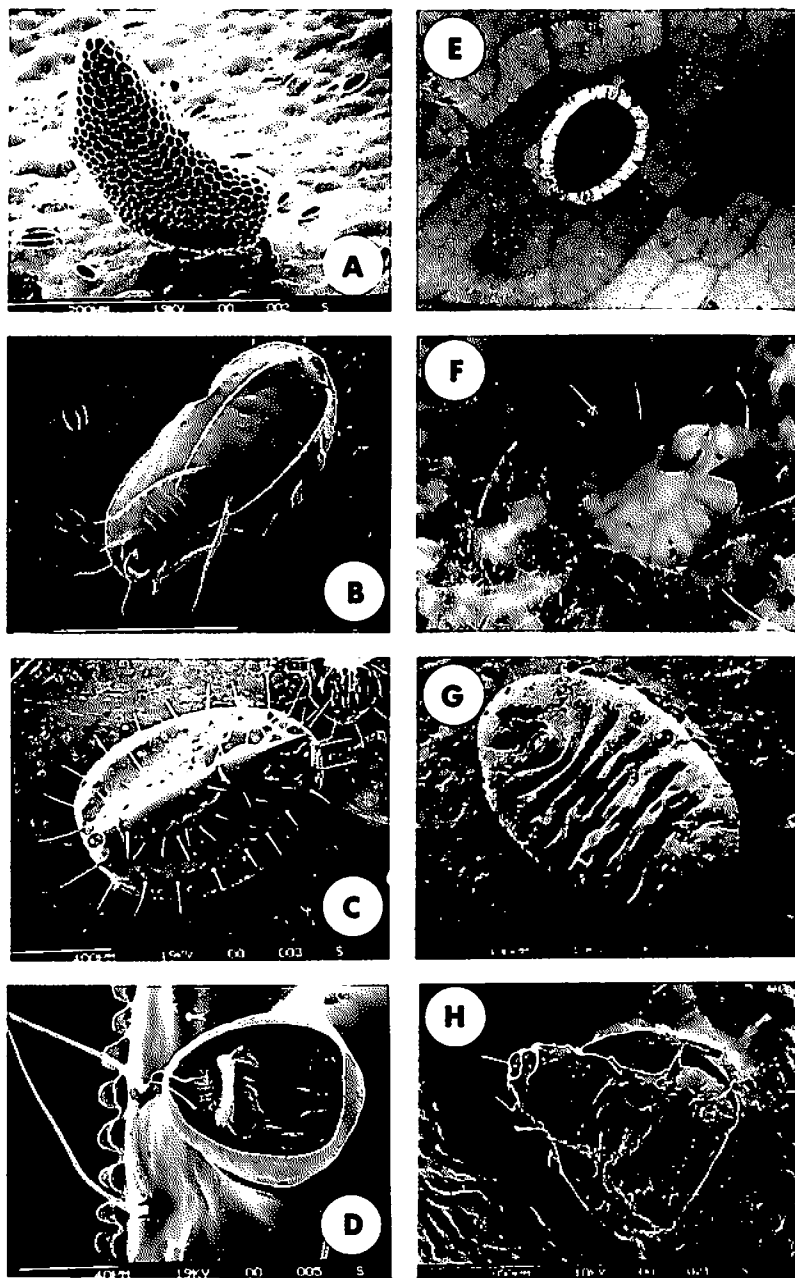


FIGURE 1. A-E *Aleurocanthus spiniferus*: A. Egg, B. 1st instar, C. Pupa, D. Vasiform orifice - Pupa, E. Pupa; F-H *Aleurodicus dispersus*: F. Pupa, G. Pupa - flocculence removed, H. Vasiform orifice - Pupa.

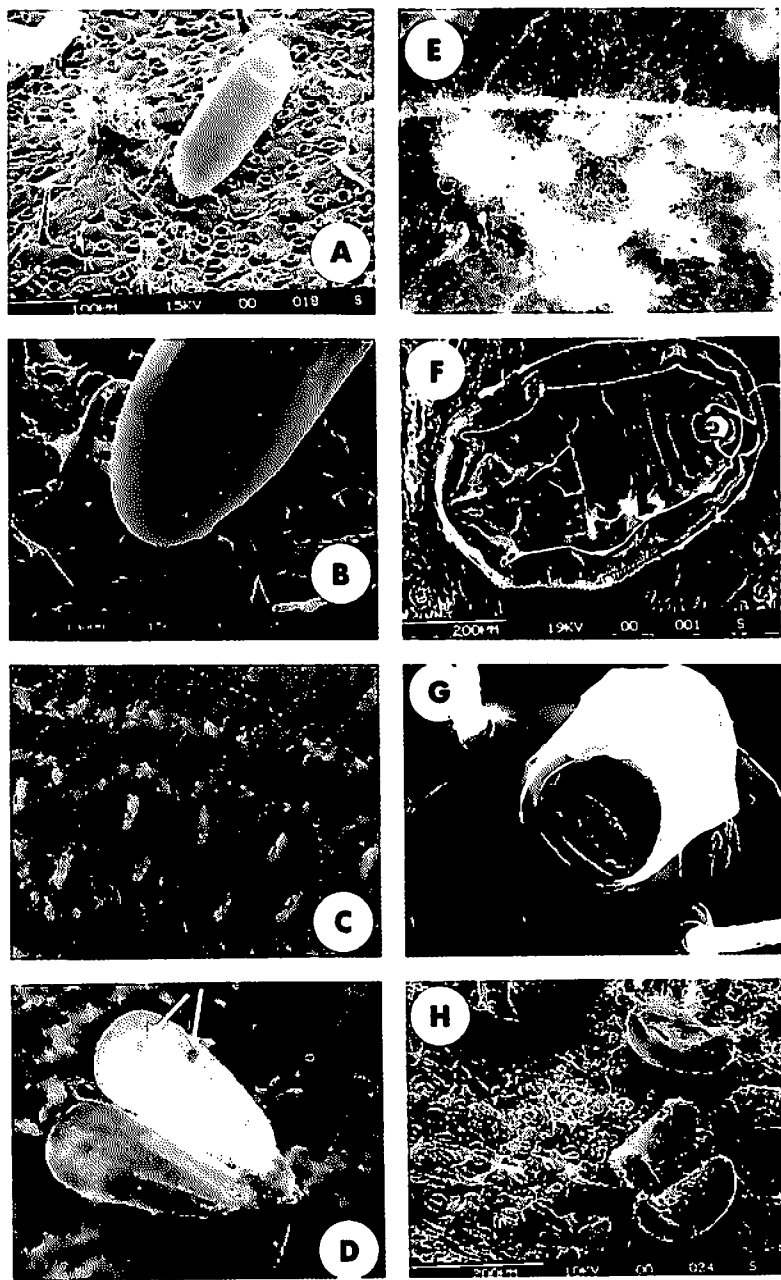


FIGURE 2. A-D *Aleurodicus dispersus*: A. Egg, B. Egg - enlargement of pedicel, C. Eggs in spiraling configuration, D. Adult - wing markings; E-H *Aleurothrix floccosus*: E. Pupae with cotton-like flocculence present, F. Pupa - with flocculence removed, G. Vasiform orifice - Pupa, H. Eggs.

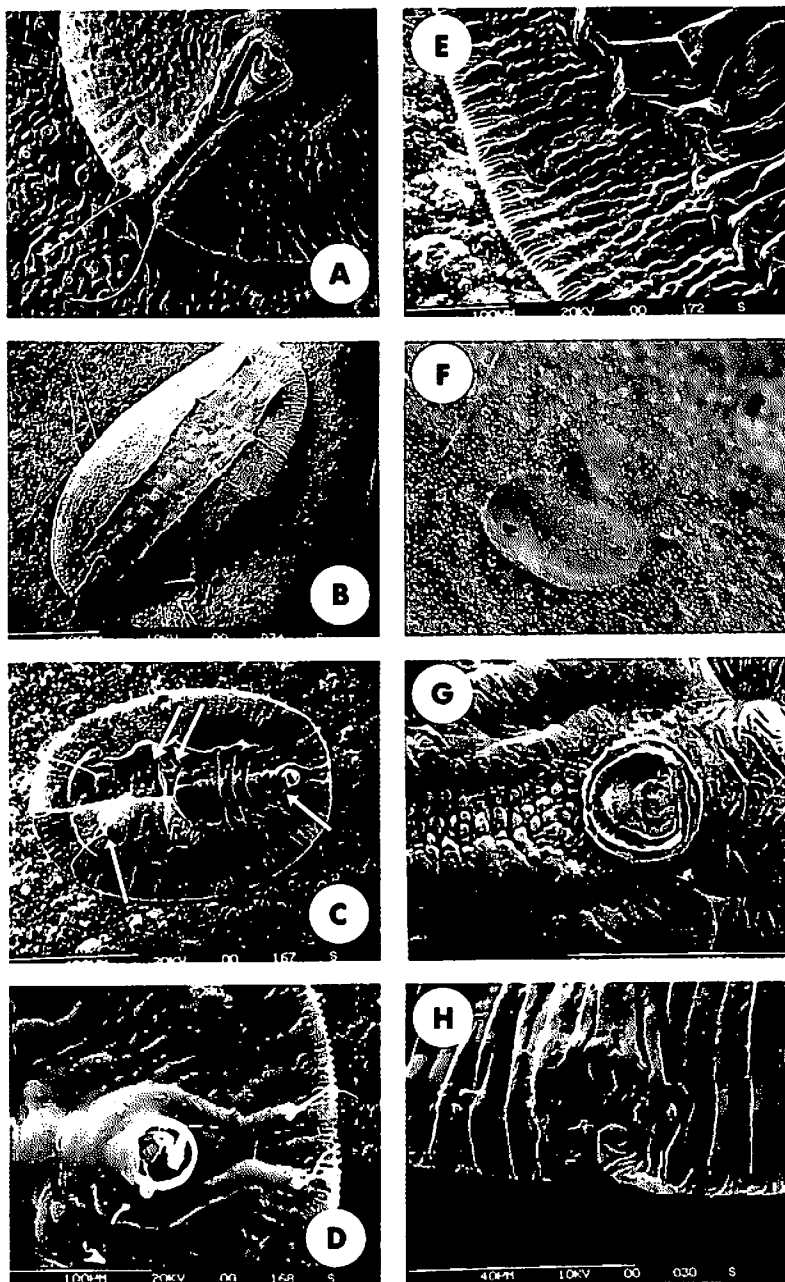


FIGURE 3. A-B *Bemisia giffardi*: A. Vasiiform orifice, B. Pupa; C-F *Crenidorsum* sp.: C. Pupa - dorsal spines, D. Vasiiform orifice, E. Lateral margin of pupa, F. Pupa; G-H *Dialeurodes citrifolii*: G. Vasiiform orifice, H. Thoracic pore and fimbriae.

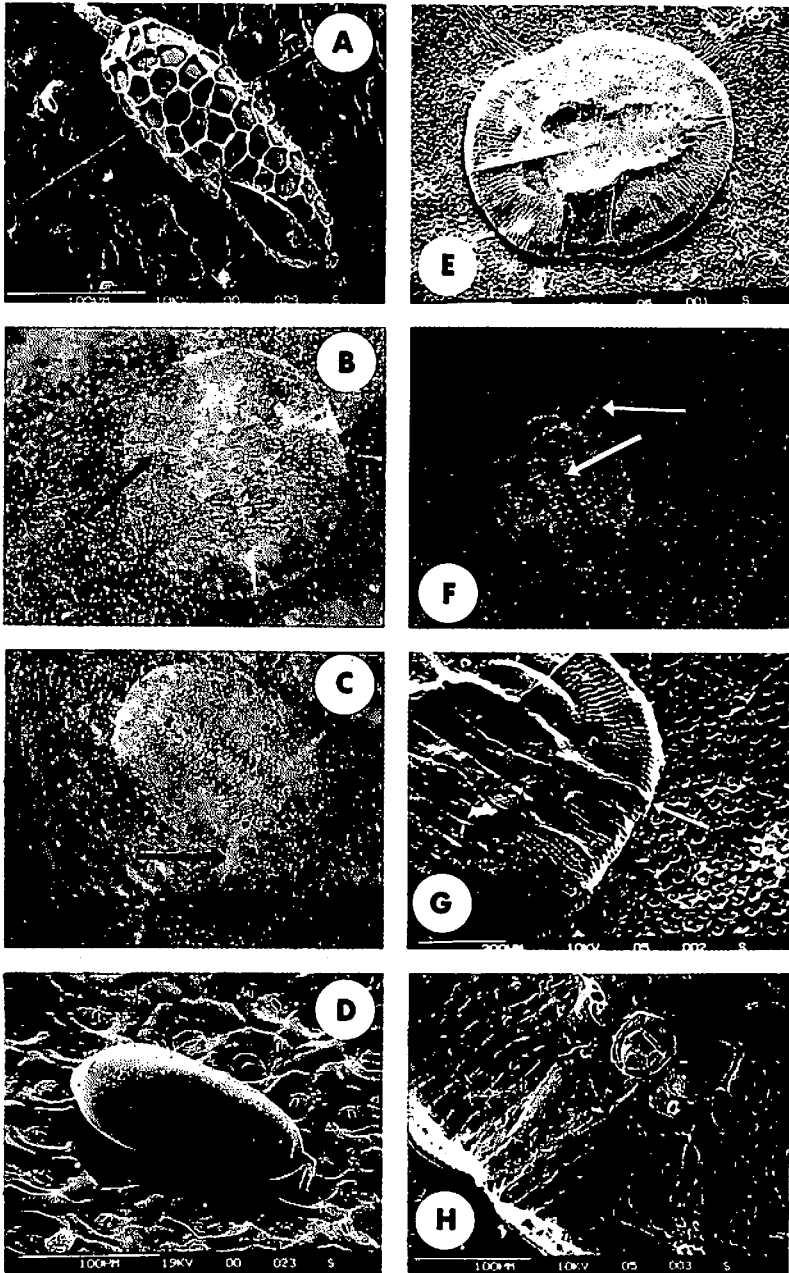


FIGURE 4. A-C *Dialeurodes citrifolii*: A. Egg, B. Pupa - thoracic tracheal fold, C. Pupa - thoracic tracheal fold; D-H *Dialeurodes kirkaldyi*: D. Egg, E. Pupa, F. Pupa - thoracic tracheal pore and median marking, G. Thoracic tracheal fold and pore, H. Vasiform orifice.

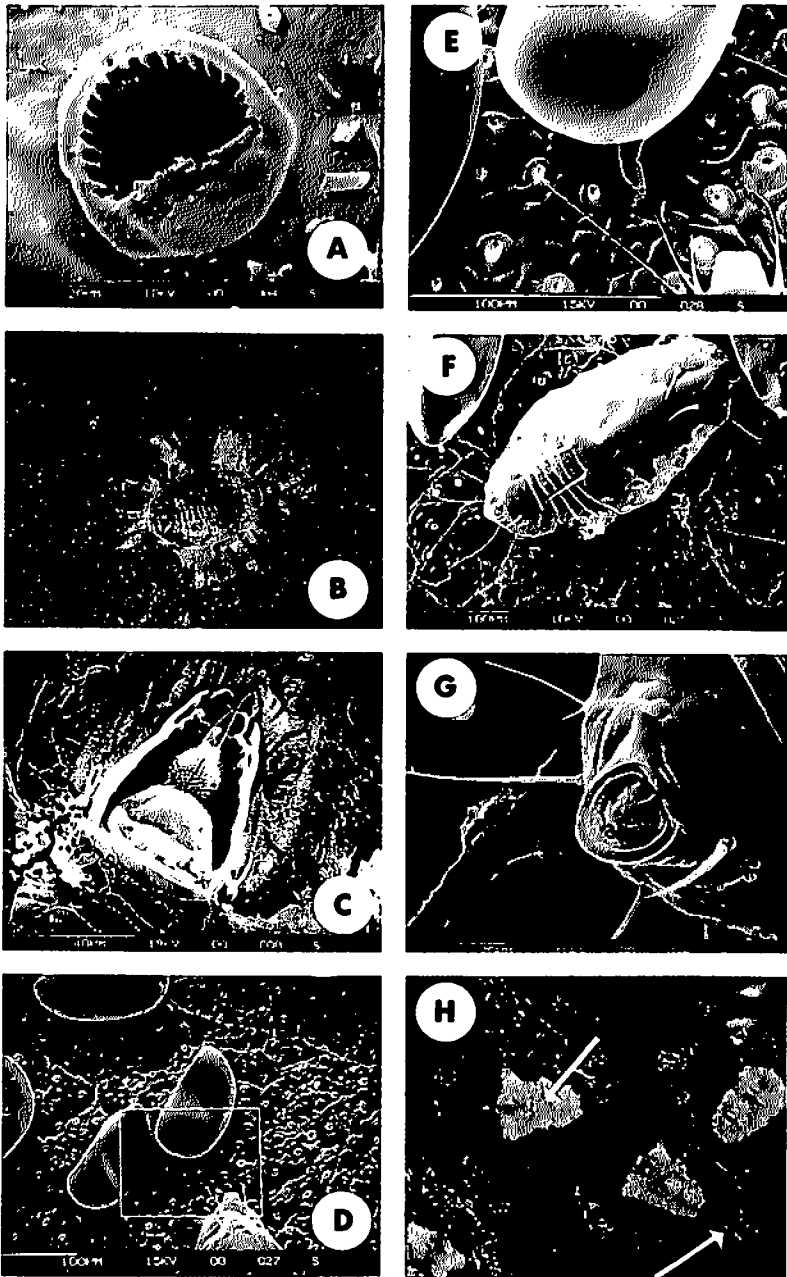


FIGURE 5. A *Dialeurodes kirkaldyi*: A. Vasiform orifice; B-C *Odontaleyrodes rhododendri*: B. Pupa (note: this specimen has been parasitized, the parasitoids emergence hole is visible on the dorsum of the pupal case), C. Vasiform orifice; D-H *Orhamoplatus mammaeferus*: D. Eggs, E. Egg-pedicel enlarged, F. 1st instar, G. Vasiform orifice - 1st instar, H. Pupae - white, powdery subtriangular dorsal patch and white tail-like secretion.

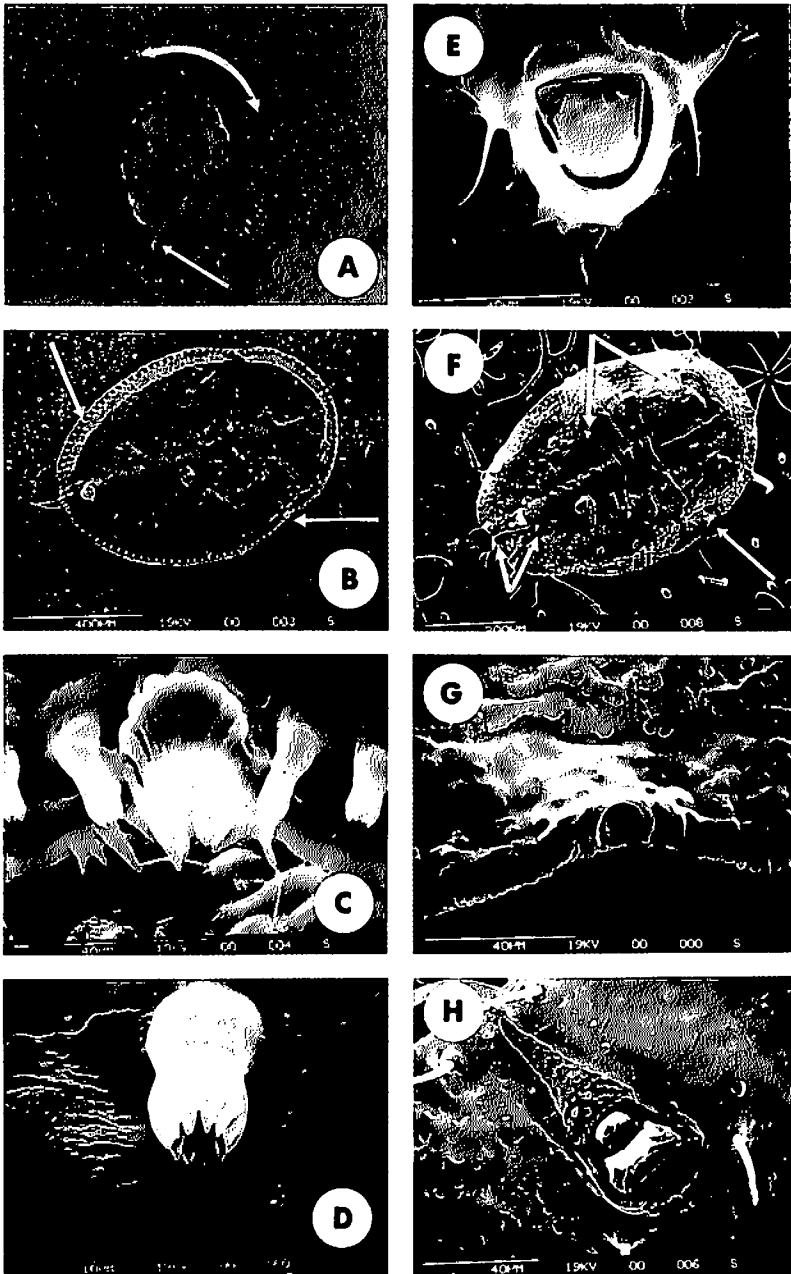


FIGURE 6. A-E *Orchamoplatus mammaeferus*: A. Pupa - clear secretions surrounding the pupa and white tail-like secretion, B. Pupa - caudal comb and marginal papillae, C. Caudal comb, D. Marginal papilla, E. Vasiform orifice - pupa; F-H *Singhius hibisci*: F. Pupa - dorsal setae and marginal semicircular indentation, G. Marginal semicircular indentation, H. Vasiform orifice.

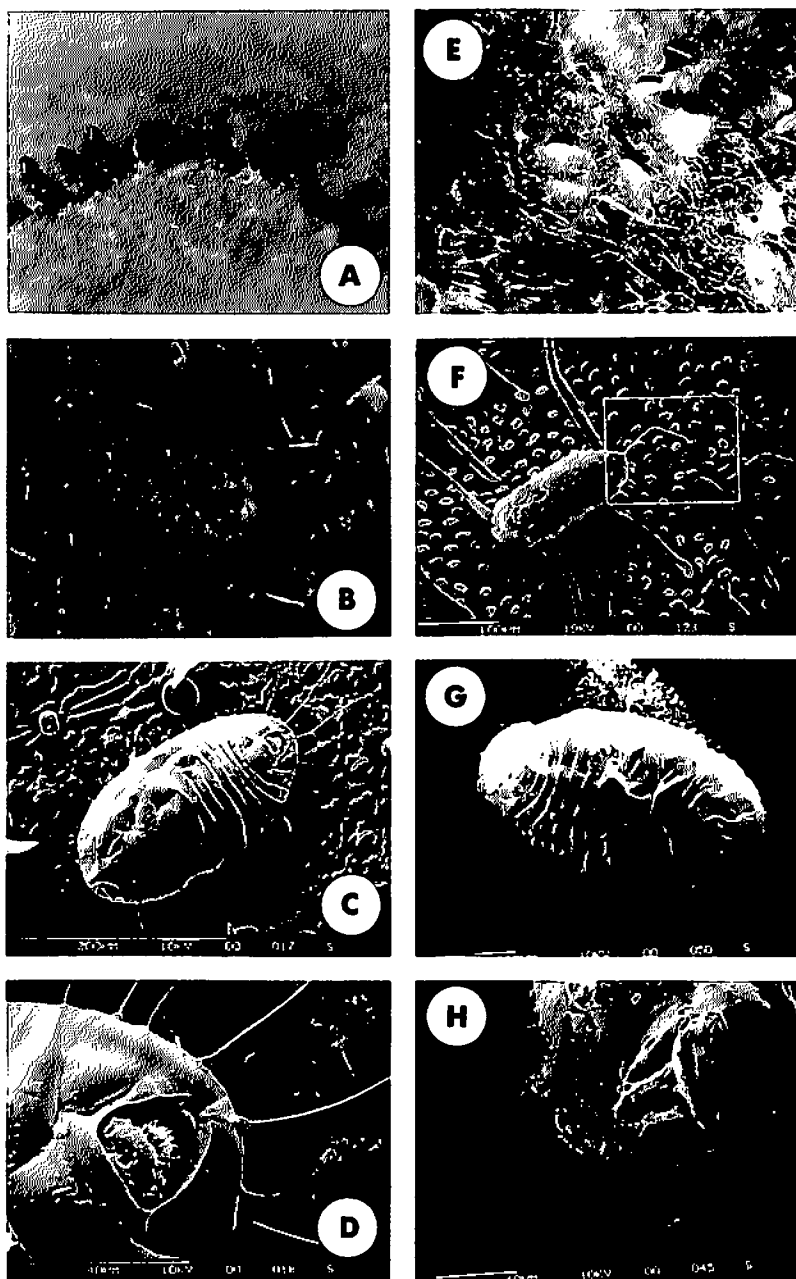


FIGURE 7. A-D *Trialeurodes vaporariorum*: A. Eggs, B. Pupa, C. Pupa, D. Vasiform orifice; E-H *Paraleyrodes naranjæ*: E. Eggs and flocculent material, F. Egg-pedicel, G. Pupa, H. Vasiform orifice.

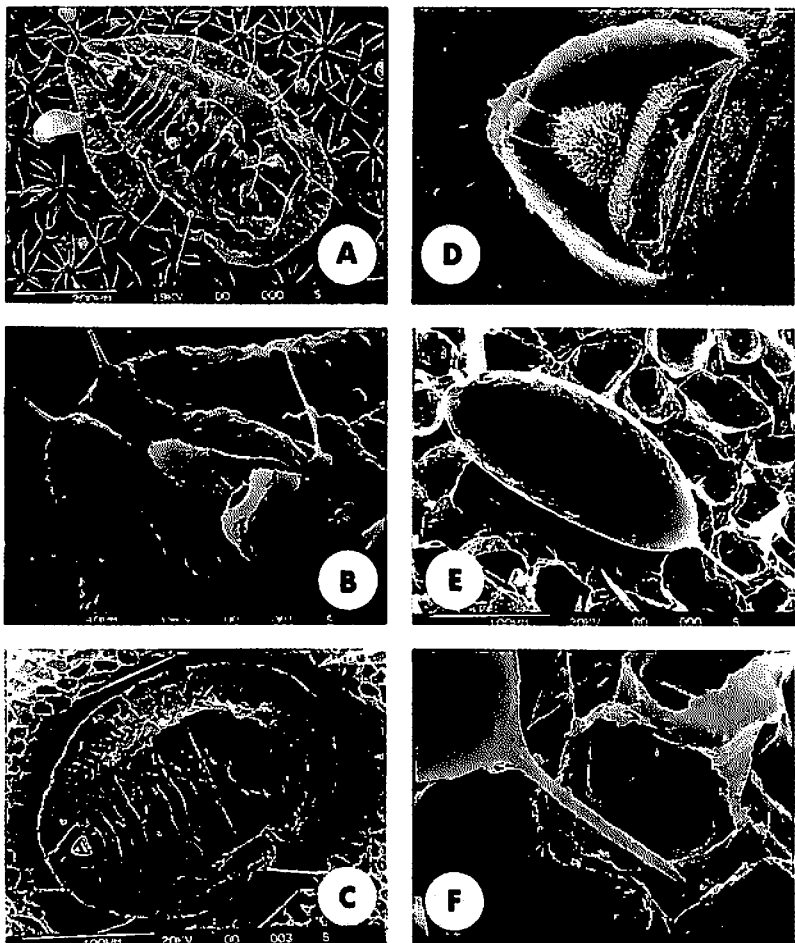


FIGURE 8. A-B *Bemisia tabaci*: A. Pupa, B. Vasiform orifice; C-F *Aleurodes shizuokensis*: C. Pupa, D. Vasiform orifice, E. Egg, F. Egg-pedicel.